PROJECT TITLE: Spontaneous Dansgaard-Oeschger type oscillations in climate models: Tipping Points in the climate system

Supervisors:
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Project keywords: (Tipping Points, Dansgaard-Oeschger (D-O) events)

Proposed start date: The placement is expected to last 8 weeks, with a flexible starting date which will be agreed upon successful appointment of the student.

Project description:

The concept of Tipping Points, critical thresholds in our climate system, helps to define the current climate emergency and strengthens calls for urgent climate action. One of the most rapid climate changes observed, are the Dansgaard-Oeschger (D-O) events. During an event, Greenland transitions from cold stadial (GS) to warmer Greenland Interstadial (GI) conditions within a decade. Surface air temperatures (SATs) over Greenland increase by 10-15°C and local snow accumulation almost doubles.

At the British Antarctic Survey, we have an ongoing model intercomparison project (SDOO: https://www.bas.ac.uk/project/sdoo/#about) to study spontaneous, DO-type oscillations in climate models (Figure 1). The main goal of SDOO is to cross compare existing simulations using a common set of diagnostics so we can analyse the mechanisms and the characteristics of the oscillations. In this project, the prospective student will analyse some of the SDOO model data, looking particularly at ways to test whether the system is approaching a tipping point. This is a big data problem – using TB of output from around ten Earth System Model (ESM)/climate models.

Crossing a critical threshold can result in a structural variation of the system. This is mathematically known as a bifurcation (Arnold, 1994), which assumes that the generic dynamical behavior at bifurcation (tipping point) may be detected even with only incomplete understanding of the dynamics of the system. This is especially useful for detecting early warning signals prior to a climate shift. There are two common characteristics of the approach to a bifurcation point: (1) rise in
variance of the observed signal (fluctuation-dissipation theorem: kubo, 1966) and, (2) rise in autocorrelation linked to a critical slow down.

Following the methodology of Ditlevsen and Johnsen (2010), the prospective student will help to develop a metric for quantitatively assessing and detecting early warning signals prior to a D-O tipping event.

**Work schedule (at BAS or at home):**

7 weeks: The whole project can be carried out remotely. Covid restrictions at BAS Cambridge were lifted on Wednesday 6 April 2022, so the prospective student will have the opportunity to work from home or come into the office as often as desired.

1 week: Report, presentation, or poster

**Candidate requirements**

Studying towards a Bachelors or Masters in Statistics, Engineering, Applied Mathematics, Computer Science or related field.

**Background reading and references**
